

Wilder (B. 9.)

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## BRAIN-WEIGHT, Etc.

Reprinted for his students, from his article "The Gross Anatomy of the Brain," (Wood's "Reference Handbook of the Medical Sciences," viii, 107-164), by Burt G. Wilder, M.D., Professor of Physiology, Comparative Anatomy and Zoology, Cornell University.

§ 276. Prop. CXLVIII. The depth of fissures should be determined either (a) by sounding, as practised by Jensen (*Archiv für Psychiatrie*, 1874, p. 596) or (b) by the careful removal of interfissural blocks capable of of being replaced and secured by pins, as represented, e.g., in Figs. 4776 and 4787.

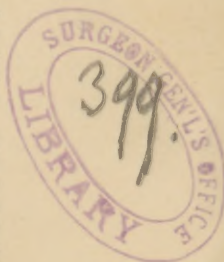
§ 277. Prop. CXLIX. The fissures of idiots, of insane persons, and of criminals are usually peculiar; whether these peculiarities have the significance sometimes ascribed to them, and especially whether murderers' brains present characteristic features, are questions of exceeding interest and importance. The writer does not feel ready, as yet, to discuss them, but refers with confidence to the admirable paper of Dr. Charles K. Mills, *Jour. of Nerv. and Mental Disease*, 1886, September and October.\*

§ 278. Prop. CL. It seems at least probable that the well-marked human races present fissural peculiarities; careful figures and descriptions of such are not yet numerous enough to serve as a basis for useful generalization. The paper of Dr. Mills above cited refers to mulatto brains, and contains figures and a preliminary description of a Chinese brain, a most rare and interesting specimen. The brain of a Bushwoman has been described and figured by Marshall (see § 274), and that of a Hottentot is discussed by Wyman, *Boston Soc. Nat. Hist. Proceedings*, ix., 353.

§ 279. Prop. CLI. Abundant fissuration is of course one of the factors in cortical extension, but not the only or perhaps the principal one. Whatever may be the average derived from a considerable number of cerebrums, more or less fissured, there occur exceptions, such as the two brains shown in Figs. 4778 and 4779. The mechanic's cerebrum is fissured to an unusual degree and the insula completely hidden; the philosopher had a larger brain, but its lateral aspect presents an equally unusual absence of fissural complexity and the insula is exposed.

§ 280. Prop. CLII. For the determination of the correlation between mental characteristics and cerebral peculiarities it is desirable that the brains of well-known persons of marked idiosyncracies should be carefully preserved and thoroughly studied. Among the individuals best adapted to subserve this object are college professors, who have usually somewhat sharply defined capacities and attainments, and are the subjects of prolonged and discriminating observa-

\* To some persons the idea that there is a "criminal type" of brain is very attractive; that this is not yet accepted by all neurologists may be seen from the following conclusions of Schwenkendiek ("Untersuchungen an zehn Gehirnen von Verbrechern," etc., 1882), substantially as stated in the *American Journal of Neurology and Psychiatry*, i., 569-573: "These brains are irregularly developed, but we cannot yet assert that they present a reversion to animal brains or that there is a criminal type; with regard to Benedikt's chief claim that fissural confluence is characteristic of the criminal brain, just the reverse was found to be the case."



presented by the author.

tion and discussion among their trustees, colleagues, and students; no professor's brain should be lost to neurological science.

§ 281. Prop. CLIII. Considerable interest attaches naturally to the comparisons of brains as to *weight*, absolute and relative, and as to other points, between individuals, the sexes, races, ages and different species. Any present statement of the case must be largely negative and qualified, hence neither compact nor altogether satisfactory. Many of the following figures and generalizations are taken from the excellent account of the subject in *Quain*, ii., 382-384.

§ 282. Prop. CLIV. In comparing brains, and especially cerebrums, the following data are desirable but seldom all attainable. 1. Absolute weight, after removal of the dura. 2. Relative weight, *i. e.*, in comparison with that of the entire body. 3. Weight of the cerebrum, including the thalami. 4. Form (very difficult to determine upon the fresh brain). 5. Degree of fissuration. 6. Depth of fissures. 7. Arrangement of fissures. 8. Age. 9. Sex. 10. Cause of death. 11. Degree of emaciation. 12. Mental state (insanity, etc.). 13. Thickness of cerebrocortex. 14. Firmness of the cortex. 15. Chemical and histological integrity.

§ 283. Prop. CLV. The *average weight* of the adult human brain, according to Quain (ii., 382) is 1,247 grams (44 oz. avoirdupois) for the female and 1,400 (49.4) for the male. The more recent conclusions of Bischoff and Mendel make both these a trifle lower. In a series of 278 male brains, the *maximum weight* was 1,842 grams (65 oz.) and the *minimum* 964 (34 oz.). Among 191 female brains the corresponding figures were 1,587 (56) and 879 (31). Certain female brains are heavier than certain male; for example, Gambetta's weighed only 1,180 (41.62), while that of an insane woman, fifty-seven years old (No. 2268 of the Cornell University Museum), has an *alcoholic weight* of 1,285, and (assuming this to represent 80 per cent. of the original) may have weighed 1,606 when fresh. It is to be noted, however, in this connection (1) that there are some reasons for regarding unusual weight as a not infrequent concomitant of mental disturbance; and (2) that there are not, as yet, recorded the brain-weights of any women known to have been intellectually superior. The comparison between the two sexes is not, therefore, altogether satisfactory.\*

§ 284. Prop. CLVI. In *absolute weight* the human brain is exceeded by those of whales and porpoises (2,265-3,171 grams, 5-7 pounds) and of elephants (4,530 and upward, 10 pounds or more). The lowest of these figures is higher than the greatest weight (1,983.80, 70 oz., or 4 pounds 6 oz.) claimed for a

\* In addition to the works and papers cited in § 293, the following may be consulted respecting brain-weights: Romanes, "Mental Differences between Men and Women" (*Nineteenth Century*, May, 1887, pp. 654-672); Hammond, W. A., and Gardener, Helen H., Discussion of "Sex and Brain-weight" (*Popular Science Monthly*, 1887, xxxi., 266, 554, 608); Topinard's summary of Broca's observations (*Revue d'Anthropologie*, v., fasc. i., 1882 abstracted in *Nature*, xxv., April 27, 1882, p. 608); Wilson, Daniel, "Brain-weight and Size, in Relation to Relative Capacity of Races" ("American Association Proceedings," 1876); Tiggess, "Das Gewicht des Gehirns, und seiner Theile bei Geisteskranken" (*Allg. Zeitsch. für Psychiatrie*, xiv., 97, abstract in *Centralblatt für Physiologie*, Jan. 19, 1889, 552-554). Bischoff's "Hirngewicht."



*non-hydrocephalic* human brain, viz., that of a negro described by Dr. C. Tompkins, *Virginia Med. Monthly*, Jan., 1882, pp. 291-293.\*

§ 285. Prop. CLVII. But in no animal other than those mentioned above (§ 284) is the brain as heavy as the smallest human, viz., that of a Bushwoman, 871 grams (30.75 oz.).† In a bull it was 337 grams, in a lion, 198, and in the adult gorilla only 425 (15 oz.) (Owen iii., 144). The largest ape brain is then only half as large as the smallest normal human.

§ 286. Prop. CLVIII. The *relative weights* of the body and brain vary greatly according to the condition of the former at death. Most of the cases tabulated were of persons dying after more or less prolonged disease, and the figures are as follows: for 81 males, 1 to 36.50; for 82 females, 1 to 36.46; according to Bischoff, 1 to 35.20. Quain concludes that in healthy individuals dying suddenly from disease or accident, the ratio is probably about as 1 to 45. In comparing man with animals in this respect this last ratio should commonly be adopted.

§ 287. Prop. CLIX. Owen estimates the adult male Gorilla at 200 lbs., or 90,720 grams, and the brain would be as 1 to 213; in a bull it was as 1 to 2,000, and in a lion as 1 to 555. On the other hand, in a sparrow the ratio was as 1 to 25; and in a marmoset (*Midus*) 1 to 20, (Owen, iii., 142); and in *Jacchus vulgaris* (No. 664, Cornell University Museum), as 1 to 19. But it is to be noted that in these small monkeys, as in birds, the cerebrum is *not fissured*. Perhaps the least misleading mode of stating the case is to say that the human brain is relatively heavier than that of any animal larger than a cat, in which the cerebrum is fissured.

§ 288. Prop. CLX. With many intellectually eminent men the brain-weight has been decidedly above the average (1,400 grams, 49.4 oz.); *e. g.*: Broca, 1,484 (52.34); Louis Agassiz, 1,495 (52.73); Schiller, 1,580 (62.96); Cuvier, 1,861 (65.64, commonly given as 64.50); Turgenieff, 2,120 (74.74). Yet the weight has been below the average with several persons of undoubted mental power, *e. g.*, Gambetta, 1,180 (41.62); Dante, 1,320 (46.56); Liebig, 1,352 (47.69). Finally, with several unintellectual individuals the brain-weight has been high, *e. g.*, a bricklayer who could neither read nor write, 1,899.45 (67 oz.), reported by Dr. Morris in *British Medical Journal*, October 26, 1872; the negro mentioned in § 284, 1,983.80 (70 oz.). Mendel concludes (Eulenburg's *Real-Encyclopädie*, vii., p. 594) that any brain weighing less than 900 grams

\* The brain of a Chippewa Indian squaw, 85 years old, rachitic, in the Army Medical Museum, Anatomical Section, No. 1031, weighed when fresh 73.5 ounces (2,083.72 grams) but it was *hydrocephalic*, and the Curator, Surgeon J. S. Billings, U. S. A., informs the writer that the "ventricular liquid was probably included in the weight."

† It should be noted, however, that the weight of the Bushwoman's brain as here given was *estimated* by Marshall (*Philosophical Transactions*, cliv., 506) in the following way: The weight when hardened in alcohol was 21.77 oz. (617 grams); he assumes that it had lost seven twenty-fourths (between a third and a fourth) of the original weight, which would then have been as stated above. But the writer's observations lead him to regard the average loss of weight as only about *one-fifth*; upon this basis the original weight of the Bushwoman's brain was only 771 grams (27.19 oz.), not quite double that of the Gorilla. Careful and repeated observations are needed to determine the usual loss of weight of an adult human brain thoroughly hardened in alcohol.

(31.40 oz.), must have come from an idiot, but this perhaps applies to the white males only. Taking all exceptions into account, it is probable that the average of say 100 brains of intelligent persons would always be found greater than that of an equal number of the unintelligent; but, since cerebral force is an element of muscular as well as mental action, it is very desirable that, as well observed by Topinard, there should be a careful determination of the difference of weight of the brain among mentally sound individuals belonging to the two distinct classes of (1) those who are engaged in intellectual pursuits, and (2) those whose vocations demand great muscular activity."

§ 289. Prop. CLXI. According to J. Reid, as quoted in *Quain* (ii., 384), the weight of the cerebrum (including the thalami and gemina, presumably) is to that of the cerebellum (without the pons and oblongata) as rather more than 8 to 1, which Owen states (iii., 145) to be a higher ratio than in any other mammal.

§ 290. Prop. CLXII. Whatever value be ascribed to brain-weight, accuracy in its determination and statement should be rigidly observed. Especially needful is it that the scales and weights be verified, and that the weighing be done in the presence of two or more, each of whom should make an independent observation and memorandum. There are considerable discrepancies in the various accounts of the brain-weights of noted persons, *e. g.*, of Gambetta, 1,160 and 1,180 grams; of Turgenieff, 2,112 and 2,120; of Cuvier, 1,800 and 1,861. Sometimes there may be typographical errors, but more often the differences are due to the process of reduction and re-reduction between the metric and other systems, or to the disregard of fractions of the ounce; for example, the brain-weight of Cuvier is given commonly as 64 oz., sometimes as 64.5, neither perhaps exactly indicating the number of grams. Again, the retention of the falx or any other part of the dura will add considerably to the weight, while the removal of the pia, commonly retained, will diminish it. Finally, the brain tissue absorbs water quite rapidly if placed in it, and dries if left uncovered. All these conditions must be borne in mind, and mentioned when the weight is stated, permitting each to make his own allowance therefor. Some other points in this connection are given in the article Removal of the Brain.

§ 291. Prop. CLXIII. *Cortical extension*.—So far as may be judged, the surest criterion of potential cerebral power is the extent of the cortical surface. From the nature of the case this is very difficult to determine, and has, in fact, been determined for only four individuals. The Wagners, father and son, measured the cortical superficies, both exposed (interfissural) and concealed (intrafissural), with an ordinary woman, a workman, a mathematician, Gauss, and a clinical teacher, Fuchs. The results were, in the order named, 1,937.40 sq. ctm. (317.5 sq. in.); 1,804.20 (291); 2,086.30 (341); 2,120.40 (342). Between the workman and the mathematician the difference was 310 sq. ctm., or 50 sq. in. This difference is regarded by Quain as less significant than it appears to the writer.